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mortuary chamber in which ancient chiefs of the island are said to have been buried. The work thus far done by archaeologists on these great monuments is comparatively superficial. Further investigations promise much additional material.

The islands of the Pacific present most instructive problems in physical anthropology. There is every evidence that renewed study in this line would reveal much new material.

The strongest appeal that the anthropologist can make for additional field work on the prehistoric inhabitants of the Pacific and their culture is their bearing on the unity or plurality of origin of man. Culturally the aborigines of America and those of the Pacific islands were in the Stone age when discovered. We naturally look to the Pacific for the cultural kin of the American race. It is desirable that extended observations be made on the Polynesians to supplement what is known of the Stone age of the continents, especially America.

I would naturally lay great stress on a systematic survey of the aboriginal monuments in the Pacific islands to discover their history. The first step would be to make an archaeological reconnaissance to determine the distribution and character of antiquities. Having determined in this way which one of the many sites of human occupation shows superficial evidences of the greatest age, excavation should be made upon it to ascertain its age, history and relation of former inhabitants, as shown by skeletal material, remains of architecture, minor artifacts and other archaeological material.

MID-PACIFIC LAND SNAIL FAUNAS

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It may seem presumptuous to infer from the distribution of little land snails on scattered Pacific islands, that large Pacific land areas have disappeared in Tertiary time; but if we accept the general principle that similar organisms have evolved from a common ancestry, this bold inference seems justified. Briefly, the reasons are as follows:

The land snails of the Pacific islands, as far as now known, may be divided into two groups: those living on low islands and on the shore zone of high islands, and those inhabiting the forests of high islands. Many of the first group have a wide distribution suggestive of dispersal by human or other adventitious agency and are therefore not significant in the present problem.

The most striking features of the second group in Polynesia and Hawaii are: (*a*) The absence of all the highly evolved continental groups of land snails. There are no Helicidae, no slugs, no carnivorous snails, none of the operculate Cyclophorid snails—in a word, none of the groups that have constituted the bulk of all known continental faunas since the Eocene. (*b*) The prevalence of groups that belong, by their relatively primitive anatomical structure, to early branches of the phyletic tree of the land snails. Some, such as the Amber snails (Succinea), and the Endodonts, have relatives in Mesozoic continental deposits, and still form a small part of the modern continental faunas. Some, like the Helicinidae, are presumed from their structure to be ancient groups, early terrestrial adaptations derived from the most primitive group of marine Prosobranch snails. (*c*) Another series of families, the Achatinellidae, Amastridae, Partulidae, Tornatellinidae and Pupillidae, belong to a primitive group having pallial organs like the aquatic snails Lymnaea and Auricula. They form a primary division of the land snails called Orthurethra. One may compare their relation to the dominant groups of continental snails to the relation Monotremes bear to the placental mammals.

This low group is represented on the continents by such minute forms as the Pupillidae and Valloniidae, which were present in essentially their modern forms in the Eocene, and still seem to exist by grace of their insignificance, occupying a station which no higher group has been modified to fill.

In the island world, this primitive group has had a wonderful evolution. It comprises all of the large snails, and outnumbers all other groups. Shell forms have been evolved paralleling most of those of continental snails, except that up to this time no shell-less, sluglike form has been found. There are adaptations to all varieties of terrestrial and arboreal stations.[1]

The greatest variety of Orthurethra is in the mid Pacific; westward a few forms extend into islands also inhabited by some distinctively continental families of snails. Fiji is the extreme outpost of the latter. There they stop abruptly. The presence of this border of continental snails in the southwest Pacific has been looked upon by Hedley and others as evidence of former continental extension, while some zoogeographers attribute it to over-sea drift. The suggestion may be entertained that here a later fauna has been superposed upon an earlier.

Where shall we look for the source of this unique Pacific fauna? It is known that on the continents the chief existing families of land snails were already established in the Eocene; and that many of the existing genera were represented in the Oligocene. If Pacific faunas were derived as has often been claimed, from waifs drifted thither on 'natural rafts' or carried by birds from the continents, such migration must have stopped as an effective factor in colonization before Tertiary times, for otherwise it seems unaccountable that *all* dominant Tertiary snails of the continents are absent, as with our present knowledge, they appear to be. There is small reason for believing that supposed means of mollusk transportation which have failed during the three or four million years of Cenozoic time, were any more efficient before that. It appears that here, as on the continents, their dispersal has been chiefly by their own known powers of locomotion.

It is difficult to escape the conviction that the archipelagoes of today are superposed upon folds of vastly greater extension, now lost by subsidence, upon which the Pacific snails were evolved, and which served as paths for their migrations. It may be inferred that in the Mesozoic or earlier, continental connections, or close proximity, gave the snails of that time access to the Pacific lands. It is not necessarily inferred that at any one time an area of continental proportions existed. It is of course heterodox to doubt the absolute permanence of oceanic basins, but I must confess that my faith in the good old doctrine has been shaken. It seems conceivable that the doctrine of isostatic balance is not incompatable with the idea that some former areas of low gravity, perhaps intermediate between that of the continents and the sea floors, have been depressed in late geological times.

The limits of my space do not allow discussion of much evidence favoring the distribution of mid-Pacific land snails by former land extensions. The great amount of differentiation among the primitive Pacific snails indicates a very long period of evolution—far longer than any estimate of the duration of the present volcanic islands. The affinities of island faunas are highly suggestive, even though so imperfectly known, of distribution along certain trends. The trade winds have always blown from eastward, yet there is absolutely no snail of a distinctively American group known in the Pacific faunas.

Some light may be thrown upon the subject of inter-island distribution or migration by a brief view at close range of a limited area. In the Hawaiian Islands, where alone I have had personal experience, no large species of land snail is found living on more than one island, but adjacent islands, such as Molokai, Maui and Lanai, have closely related species. The tree snails and allied ground snails inhabit mountain forests, mainly above 1000 feet, but before the destruction of the lower forests they came down to less than half that elevation, though not into the shore zone. Each species has its definite territory, sometimes one, sometimes several adjacent ridges. They bear living young. If their dispersal were effected to any extent by birds, one would expect to find sporadic colonies, at least in a few cases, instead of the logical and definite distribution which is actually found.[2] Inter-island drift upon trees, here as throughout Polynesia, is excluded by the absence of large streams to transport such materials to the shore. The present currents and trades would not drift from island to island. Finally, the conditions on the shore zone are such that a forest snail thrown upon the strand could not exist.

The Pleistocene deposits of land shells, though only now beginning to be explored, show that even then the island fannas were more closely related than at present. Numerous relatively large species were common to two or more islands, while at the present day there are none. All the facts are explicable on the theory that the islands have been successively isolated by subsidence. Otherwise the distribution of the snails seems enigmatic.

It is obvious that speculation upon the origin and migrations of the Pacific faunas, such as I have been allowing myself to indulge in, will have a vastly broader basis when we have adequate knowledge of the faunas of all the principal high islands. Hypotheses which now seem reasonable may be confirmed, or they may be definitely excluded from further consideration. All the high islands of the Caroline, Austral and Hervey groups should be investigated. In Samoa and the Marquesas we certainly know only a fragment of the fauna. Outlying islands, such as Rapa, specially need examination. On the American side, Juan Fernandez and Mas-a-fuera call for investigation.

At present it may be said that we have a good, though by no means complete knowledge of the snails of the Hawaiian Islands, which resident naturalists are zealously working on. In the Society Islands, through the work of Andrew Garrett, we have a fair knowledge. In Fiji, Tonga and scattered islands of other groups, it is likely that most of the large forms are known, the small and minute scarcely at all. Work on land snails has been sporadic, in large part done by chance visits of naturalists whose chief interest was in other subjects. Everywhere material must be preserved for anatomical study, as the affinities of many land snails can be worked out only from the soft parts, and at present we are guessing at the taxonomy in some of the families. Outside of Hawaii but little material has been collected for anatomical study.

A word as to the 'low islands.' A group of small or minute land snails has been adapted to atolls and the shore zone of high islands.

Many of the species have a wide distribution on different islands or different groups. To be found in any coconut grove, hiding under leaves or wood to which they stick fast in dry weather, they might easily be carried about by human agency. Some groups of small operculate snails, such as Truncatella, live only near the sea, where the salt breeze blows. These seem particularly adapted to distribution by flotsam, yet even they fail on the more outlying islands, some of which have rich faunas of forest snails. The atoll faunas are poor. Thus, Funafuti has 7 species, Palmyra 1; none being peculiar to these islands. Contrast Hawaii, with over 800 species on the 8 islands, or the far less explored Society group with over 100.

Except in Hawaii, such investigation as is needed in the Pacific is beyond the reach of the individual naturalist. It must be done soon, or much of the data will surely be lost forever. The introduction of continental plants and insects, particularly the all-devouring ants, of goats and cattle, of snails and slugs from Europe, Java, Japan and China, has already made serious inroads upon the native faunas and floras. Every year sees the passing of some island species, perhaps a link in the chain of evidence which cannot be replaced. On some small islands, such as Kahoolawe (south of Maui, area 69 square miles), the destruction has already been completed. The native fauna and flora, with whatever they had to tell us, has disappeared in the last 50 years or less, except as we can recover fragments from the aeolian deposits in ravines. Over many miles the very humus has blown away, and desolation like a lunar landscape meets the eye. Such a fate awaits many a Pacific island, we cannot doubt. A comprehensive scientific exploration of these unique faunas must be made while yet it can be done, before they are mutilated beyond restoration.

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[1] The snails of the group Orthurethra best known to the general zoological reader are the Achatinellidae, which formed the basis of Gulick's contributions to evolution doctrinex, brought together in his *Evolution, Racial and Habitudinal,* published by the Carnegie Institution of Washington, 1905. Also the Partulidae, which many travelers in Polynesia and Micronesia have noticed.

[2] The data may be found in the writer's *Manual of Conchology,* vols. 21–23.